

MODULAR FURNITURE

Field of Invention

The present invention relates generally to modular furniture and more specifically to furniture member connectors, modular furniture systems, and methods of connecting and disconnecting furniture members.

Discussion of Related Art

Furniture assembly, whether performed by the consumer or the furniture manufacturer, can be a time-consuming process involving the use of tools, numerous pieces of hardware, and extensive, complex instructions. The relative ease or difficulty of assembly often has an impact on the cost to manufacture and/or the marketability to the consumer. Additionally, the ease of assembly can also have a substantial effect on the utility of a modular furniture system.

Furniture that is shipped as a packaged kit of separate furniture parts and is intended to be assembled by a retailer or a consumer is often referred to as knock-down furniture or assembly furniture. Knock-down furniture kits are typically shipped in large flat packages that include flat furniture members (e.g., walls, bases, doors) and a set of instructions for assembling the furniture members into a piece of furniture such as a desk or a shelving unit.

A fairly common method of connecting the furniture members of a knock-down furniture kit is described in U.S. Patent No. 4,886,326 to Kuzyk. A cam lock is inserted into a drilled recess in a first furniture member and a connecting bolt, attached to a first furniture member, is inserted through a bore into the cam lock. The cam lock is rotated to lock the connecting bolt in place. In this manner the two furniture members are connected at a point connection. Several of these point connections are provided along the edges of furniture members that are to be connected. Typical knock-down furniture kits include furniture members and other components that are not designed to permit easy disassembly without a deterioration in the usefulness or aesthetic quality of the furniture members and/or other components, such as connectors. In typical prior art knock-down furniture, the

furniture members and connection system typically are designed to allow only one assembly configuration. For example, otherwise similar furniture members can have pre-drilled holes that align only with certain fastener locations or furniture members can have only one presentable face.

A simplified system for connecting furniture members would significantly reduce furniture assembly time requirements. Fewer parts, interchangeable parts, flexibility of assembly configuration and secure connections can each help to provide a straightforward system for connecting furniture members to form furniture assemblies.

SUMMARY OF INVENTION

In one embodiment of the invention, a furniture connector comprises a first furniture-engaging portion including and/or configured to engage a fastening element that is adapted to enable fastening of the first furniture-engaging portion to a first furniture member, the fastening element not being integrally formed with the first furniture-engaging portion. The furniture connector further comprises a second furniture-engaging portion including and/or configured to engage a fastening element that is adapted to enable fastening of the second furniture-engaging portion to a second furniture member, the fastening element not being integrally formed with the second furniture-engaging portion. The first and second furniture-engaging portions have a shape and thickness selected to enable the first furniture-engaging portion to be matingly engaged with a first groove present within the first furniture member, and to enable the second furniture-engaging portion to be matingly engaged with a second groove present within the second furniture member. The first and second furniture-engaging portions that include and/or are configured to engage a fastening element are configured to be contained within the first and second grooves.

In another embodiment of the invention, a furniture connector comprises a first furniture-engaging portion and a second furniture-engaging portion, each furniture-engaging portion having a shape, a width and a thickness selected to enable the furniture-engaging portion to be matingly engaged with a groove of a furniture member. Each furniture-engaging portion further has a length, the length being

greater than the width, wherein at least one furniture-engaging portion is constructed and arranged to enable it to become fastened to the furniture member using a fastening element without irreversibly changing the structure of the furniture member.

In another embodiment of the invention, a modular furniture system comprises a plurality of furniture members, at least one furniture member thereof having a first face, a second face, and at least one adjacent connecting edge. The modular furniture system further comprises a plurality of connectors, at least one connector thereof adapted to interconnect at least two of the furniture members, wherein at least one connecting edge has a first angle portion thereof that forms a first smallest angle with respect to the first face of greater than about 90° and a second angled portion thereof that forms a second smallest angle with respect to the second face of greater than about 90°.

In still another embodiment of the invention, a kit of parts for assembling furniture comprises a plurality of furniture members, at least one furniture member thereof having at least one groove formed therein, and a plurality of fastening elements. The kit of parts further comprises a plurality of furniture connectors, at least one connector comprising at least one furniture-engaging portion having at least a portion thereof including and/or configured to engage at least one of the fastening elements, which at least one fastening element is adapted to enable securing of the furniture-engaging portion at least partially within the groove of a furniture member having a groove formed therein, and being configured to enable fastening and unfastening of at least one connector comprising a furniture-engaging portion to the furniture member. The kit of parts further comprises instructions directing a user to insert the furniture-engaging portion at least partially into the groove and fasten the furniture-engaging portion to a furniture member having a groove formed therein with at least one of the fastening elements.

In yet another embodiment of the invention, a kit of parts for assembling furniture that can be readily disassembled and reassembled comprises a plurality of furniture members and a plurality of furniture connectors, at least one connector thereof having first and second furniture-engaging portions, each furniture-engaging portion having a length and a width, the length being greater than the width. The kit

of parts further comprises instructions directing a user to assemble the connectors and the furniture members into a first configuration of a plurality of assembly configurations, instructions directing the user to disassemble the first configuration, and instructions directing the user to assemble the connectors and furniture members into a second configuration of the plurality of assembly configurations.

In another embodiment of the invention, a method comprises acts of interconnecting a plurality of furniture members with at least one furniture connector comprising a plurality of furniture-engaging portions to form a piece of furniture of a first configuration, dismantling the piece of furniture, and interconnecting the plurality of furniture members with at least one furniture connector to form a piece of furniture of a second configuration.

In still another embodiment of the invention, a furniture assembly system comprises a plurality of furniture members and means for interconnecting and disconnecting the furniture members.

In yet another embodiment of the invention, a method comprises acts of providing a plurality of furniture connectors, each having a first furniture-engaging portion and a second furniture-engaging portion, providing a plurality of furniture members, each having a groove, matingly engaging the first furniture-engaging portion with the groove of a first furniture member of the plurality of furniture members, and fastening the first furniture member to the first furniture-engaging portion by engaging a first fastening element with a section of the furniture-engaging portion that is contained within the groove. The method further comprises acts of matingly engaging the second furniture-engaging portion with the groove of a second furniture member of the plurality of furniture members, and fastening the second furniture member to the second furniture-engaging portion by engaging a second fastening element within a section of the furniture-engaging portion that is contained within the groove.

In another embodiment of the invention, a furniture connector comprises a first furniture-engaging portion including and/or configured to engage a fastening element that is adapted to enable fastening of the first furniture-engaging portion to a first furniture member, and a second furniture engaging portion including and/or

configured to engage a fastening element that is adapted to enable fastening of the second furniture-engaging portion to a second furniture member. The first and second furniture-engaging portions have a shape and thickness selected to enable the first furniture-engaging portion to be matingly engaged with a first groove present within the first furniture member, and to enable the second furniture-engaging portion to be matingly engaged with a second groove present within the second furniture member. In this embodiment, the first-furniture-engaging portion comprises a rail having a channel.

BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings are not intended to be drawn to scale. In the drawings, each identical or nearly identical component that is illustrated in various figures typically is represented by a like numeral. For purposes of clarity, not every component may be labeled in every drawing, nor is every component of each embodiment of the invention shown where illustration is not necessary to allow those of ordinary skill in the art to understand the invention. In the drawings:

FIG. 1A shows end views of embodiments of furniture connectors having furniture-engaging portions inserted into grooves of furniture members;

FIG. 1B shows a perspective view of the furniture connectors shown in FIG. 1A;

FIG. 1C shows an assembled piece of furniture illustrating furniture assembly locations where each of the furniture connectors of FIG. 1B may be used to connect furniture members;

FIG. 2A is a partially cut-away view showing one embodiment of a furniture-engaging portion of a connector in the process of being fastened to a furniture member;

FIG. 2B shows the assembly of FIG. 2A, wherein the furniture-engaging portion is fastened to the furniture member;

FIG. 3 shows an embodiment of a connection system which incorporates an additional furniture member;

FIG. 4A shows one embodiment of a fastening element configured to secure a furniture-engaging portion of a furniture connector of the invention to a furniture member and its interrelationship with an embodiment of a furniture connector and a furniture member;

FIG. 4B shows another embodiment of a fastening element configured to secure a furniture-engaging portion of a furniture connector of the invention to a furniture member and its interrelationship with another embodiment of a furniture connector and the furniture member illustrated in FIG. 4A;

FIG. 5A shows one embodiment of a furniture assembly configuration;

FIG. 5B shows an extension added to the furniture assembly configuration shown in FIG. 5A;

FIG. 6A shows one embodiment of a furniture assembly comprising furniture members and connectors of the invention in a first configuration; and

FIG. 6B shows one embodiment of a furniture assembly assembled from the same furniture members and connectors shown in FIG. 6A assembled in a second configuration.

DETAILED DESCRIPTION

This invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of “including,” “comprising,” or “having,” “containing”, “involving”, and variations thereof herein, is meant to encompass the items listed thereafter and equivalents thereof as well as additional items.

Certain embodiments of the invention provide a furniture system that permits simplified assembly, disassembly, and reassembly of a piece of furniture, compared with many typical conventional furniture systems. In certain embodiments, an inventive furniture connector having at least two furniture-engaging portions is used to interconnect furniture members provided according to the invention. For purposes

herein, a “furniture member” comprises a shelf, wall, board, rail, door, leg, post, structural member, step, drawer, and any other furniture component that comprises a component of the useful structure of a piece of furniture or a furniture assembly, other than a furniture connector or a fastening element, as those terms are used herein. For purposes herein, “interconnect” means to connect at least two elements, such as furniture members, whether they are directly connected or connected via a third element. A connection does not require a fixed relation between the elements, as the elements may be slidingly, pivotally, or rotatably interconnected.

In one embodiment, a furniture connector of the invention extends along a substantial length of at least two furniture member connecting edges, when the furniture members are interconnected with the furniture connector. For purposes herein, a furniture member connecting edge is a furniture member edge that is adapted to be interconnected with another furniture member. In certain embodiments, furniture member connecting edges are adapted to connect to furniture-engaging portions of a furniture connector as part of the interconnection between two furniture members.

In certain embodiments of a furniture member connection system, a furniture member has at least one groove in at least one of its at least one connecting edge. At least one of such grooves may extend along the lengthwise direction of at least a portion of a connecting edge, sometimes along essentially the entire length of such connecting edge. In some such embodiments, the groove(s) may be adapted to accept and, in certain embodiments mate with, a furniture-engaging portion of a furniture connector. The furniture-engaging portion may have the structure of a rail, for example, a rectangular rail, or may be any other suitable structure that is insertable into the groove and adapted to enable fastening of the furniture member to the furniture-engaging portion. With certain embodiments of a connector that have two furniture-engaging portions, two furniture members can be interconnected by inserting each furniture-engaging portion of the connector into a groove of each of the furniture members, and fastening the furniture-engaging portions to the furniture members.

In certain embodiments, the furniture-engaging portion (rail or otherwise) that is insertable into the furniture member groove is configured to engage a fastening element. The furniture-engaging portion may include a recess such as a channel, indentation, depression, and/or hole with which a fastening element can be engaged. For example, the furniture-engaging portion may have a channel that extends along at least a portion of the length of the furniture-engaging portion and includes at least one undercut side (for example, as illustrated in FIG. 2A). In certain embodiments, with the furniture-engaging portion of a connector placed within a groove of the furniture member, a fastening element disposed in a hole in the furniture member is operated upon to engage the channel. Various embodiments of fastening elements and furniture-engaging portions are described in more detail in association with FIGS. 2A, 2B, 4A and 4B.

In some embodiments, the fastening of the furniture-engaging portions of the connectors to the furniture members is reversible. That is to say, the furniture-engaging portions of the connectors may be unfastened and removed from the grooves in the furniture members without changing the structure or damaging the connector or the furniture members so much as to cause them to be less useful or to substantially decrease their useful lifespan. By permitting removal of the connectors, certain groups of assembled furniture members provided according to certain embodiments of the invention can be disassembled from one selected configuration and reassembled into a different configuration.

According to one aspect of certain embodiments of the invention, the assembly and/or the disassembly of furniture may be simplified by using certain embodiments of the connectors and furniture members described herein. The assembly of furniture in some embodiments may require very few tools, in some cases only a screwdriver. In other embodiments, no tools are required for assembly or disassembly (i.e. only the hands of an assembler).

According to another aspect of certain embodiments of the invention, the interchangeability of the furniture members and/or the provision of various connectors may permit furniture configuration changes. For example, a shelving unit may be assembled in one of a number of configurations and later disassembled and

reassembled in a different configuration. In some embodiments, various connectors are included that can interconnect two, three, four or more furniture members. By altering the type and/or number of connectors used at a connecting edge and adding or subtracting furniture members, a user can change the configuration of the furniture assembly. A kit of parts may be provided that includes interchangeable furniture members, various connectors, and instructions. The instructions may direct a user to assemble the connectors and furniture members into a first configuration. The instructions also may direct the user to disassemble the first configuration and assemble the connectors and furniture members into a second, a third, etc. configuration, depending on the embodiment.

Using various connectors of the invention that can connect two, three, four or more furniture members also may allow a user to expand a piece of furniture by exchanging connectors and adding new furniture members to the side, top, bottom, front, and/or back of a piece of furniture. In certain embodiments, extensions may be added to furniture assemblies in this manner without the creation of double walls. For example, one side of a shelving unit may have a four-foot vertical wall that is made up of four one-foot square boards comprising the furniture members, which are attached end-to-end. A user may expand the shelving unit on such side by replacing two connectors comprising two or three furniture-engaging portions with connectors comprising three or four furniture-engaging portions, respectively, so that two additional furniture-engaging portions protrude from the vertical wall. Two additional horizontal boards may then be connected to these furniture-engaging portions of the replacement connectors. If desired, a third, vertical board may be added to the outer side of the assembly to complete the addition of a new shelf.

In another aspect of certain embodiments of the invention, the use of furniture connectors that extend lengthwise along connecting edges of furniture members can provide stronger connections between furniture members than achieved using typical connection means utilized for modular furniture. In some embodiments, the connectors can extend along essentially the entire length or a major portion of the entire length of the connecting edge of a furniture member. In certain embodiments the connectors do not extend along the entire length of the connecting edge, but the

connector length is greater than the connector width. As compared to typical conventional point connection furniture assembly systems, such connections may help distribute loads applied to the connectors and furniture members over a greater area to increase load-carrying capacity of assembled furniture and/or reduce the chance of damage or breakage.

In another aspect of certain embodiments of the invention, furniture members may be provided which include adapters that are configured to allow connection of door hinges, sliding doors, shelving, feet, wheels, handles, or other suitable items or furniture members.

According to another aspect of certain embodiments of the invention, fastening elements used to secure the furniture connectors to the furniture members can be hidden from exterior view in an assembled piece of furniture. In some embodiments, the fastening elements are employed on interior portions of the furniture members, leaving the exterior with clean lines and an aesthetic appeal. In these or other embodiments, the connectors and/or fastening elements may be made in various colors and/or textures that can be selected to be complementary to and/or visually blend in with the colors and/or textures of the furniture members, and in certain configurations, they may be visible in the completed furniture assembly to render a desired visual effect.

FIG. 1A shows end views of three furniture connectors **2a**, **2b**, **2c** being used in association with furniture members **4**, **4'**, **4''**, **4'''**. A first connector **2a** is configured to connect two furniture members **4**, **4'** together. In this embodiment, first connector **2a** has two furniture-engaging portions **5** that are insertable into grooves **6** in the furniture members. Each furniture member includes a hole in which a fastening element (not shown in FIG. 1A) may be contained for securing the furniture-engaging portion to the furniture member.

Connector **2b** includes three furniture-engaging portions and is configured to connect up to three furniture members **4**, **4'**, **4''**. Connector **2c** includes four furniture-engaging portions and can connect up to four furniture members **4**, **4'**, **4''**, **4'''**. Further embodiments of connectors that permit the connection of five or more furniture members may also be provided.

Furniture-engaging portions **5** shown in the embodiments of FIGS. 1A and 1B are rails, that is, components that extend along at least a portion of the connector length and are configured to be inserted into grooves in a furniture member. A rail may vary in width **W** along its length **L**, it may vary in length along its width, and its thickness **TH** may vary as well. Different rails of the same connector may have similar shapes and dimensions, or they may have different shapes and dimensions. In other embodiments, the furniture-engaging portions may comprise components other than rails, for example pins, tabs, etc..

The furniture members shown in the embodiment of FIG. 1A include connecting edges **8** that are beveled. The beveled connecting edges can allow connecting edges **8** to meet in a symmetrical arrangement while maintaining intimate contact between the faces **9** of connecting edges **8**. In other embodiments, connecting edges **8** need not be beveled, nor, in all embodiments, are faces **9** of connecting edges **8** required to intimately contact one another as illustrated.

As illustrated, the beveled furniture connecting edges **8** allow the furniture members to be drawn together in close contact. By including connecting edges that have two angled face portions **9** that each extend approximately halfway or less across the thickness **t** of furniture members **4**, a furniture member may be used with any one of a set of connectors that are configured to interconnect different numbers of furniture members. For example, furniture member **4** shown in FIG. 1A may be fastened to any one of connector **2a**, connector **2b** and connector **2c** and interconnected with one (left), two (right), or three (center) additional furniture members while at each of the regions of intersections of the members, the faces **9** of the connecting edges are in intimate contact eliminating gaps or open spaces.

In the embodiments shown in FIG. 1A, furniture members **4**, **4'**, **4''**, **4'''** each have a connecting edge with a first angled face portion **10** which forms an angle θ with an adjacent face **12** of the furniture member **4'** of about 135° . With first angled portion **10** having an angle of about 135° and a second angled portion **14** also having an angle of about 135° relative to an adjacent face **13**, up to four furniture members, e.g., **4**, **4'**, **4''**, **4'''** may be connected by a single connector while at each of the regions of intersections of the members, the faces of the connecting edges are in intimate

contact eliminating gaps or open spaces. In other embodiments, connecting edges may have one or more faces arranged at larger angles with respect to adjacent faces of the furniture member than illustrated, which could allow for a greater number of furniture members to be connected by a furniture connector, while at each of the regions of intersections of the members, the faces of the connecting edges are in intimate contact eliminating gaps or open spaces, provided such connector were to have a sufficient number of furniture-engaging portions **5** thereon. In still other embodiments, smaller angles than illustrated may be used which could be selected to allow up to three (120°) or only two (90° - i.e., connecting face portions coplanar to each other and normal to the adjacent faces of the furniture member) to be connected by one connector, while at each of the regions of intersections of the members, the faces of the connecting edges are in intimate contact eliminating gaps or open spaces. As mentioned immediately above, in certain embodiments, first angled portion **10** may form a 90° angle with adjacent face **12** and second angled portion **14** may form a 90° angle with adjacent face **13** to provide a squared-off connecting edge. In still further embodiments, a single angled portion may extend across the entire thickness of the furniture member.

The embodiments of furniture members shown in FIG. 1A includes connecting edges with angled portions **10**, **14** that extend approximately halfway across thickness t of the furniture member **4**, **4'**, **4''**, **4'''**. In some embodiments, each of angled portions **10**, **14** may extend substantially less than halfway across thickness t of furniture members **4**, **4'**, **4''**, **4'''**. In other embodiments, one angled portion may extend more than halfway across thickness t of furniture members **4**, **4'**, **4''**, **4'''**.

Furniture members **4**, **4'**, **4''**, **4'''** have connecting edges with angled face portions **9** oriented at angles θ of 135° in the embodiments of FIG 1A, thereby allowing up to four furniture members **4**, **4'**, **4''**, **4'''** to be connected at right angles to one another. In other embodiments, the furniture members and connectors may be constructed such that the furniture members become interconnected to one another at angles other than 90° .

Connectors **2a** and **2b** include optional protrusions **16** which slightly overlie the exposed connecting edge faces of the furniture members. The protrusions **16** may

provide certain structural advantages, such as securing intimate contact between connectors **2a** and **2b** and furniture members **4** and eliminating or reducing gaps or open spaces between connectors and the outward-facing beveled edges of the furniture members. The protrusions **16** may also help to maintain the alignment of furniture members when furniture members are drawn together. The protrusions **16** do not necessarily have to overlie the exposed faces of the furniture members. For example, the protrusion **16** of connector **2a** may, in non-illustrated embodiments, protrude straight out from connector **2a** without contacting an outer surface of furniture members **4** and **4'**. In another example, there may be no protrusion **16** present, i.e., the connector **2a** may be flush with the surface formed by the exposed surfaces of the two furniture member faces. In another example, shown in FIG. 1A, a protrusion **16** of furniture connector **2b** may form a planar surface between two furniture members **4'** and **4''** extending in opposite directions. In yet another example (not illustrated), connector **2b** may have a region in place of protrusion **16** that forms a flush planar surface along the surface formed by the two furniture-engaging portions **5** extending in opposite directions. Analogously, the protrusion **16** of connector **2a** may be enlarged to cover the two furniture member faces **9** and form a flush planar surface along the surface formed by the two furniture-engaging portions **5** extending in opposite directions.

While the furniture connectors are shown in FIG. 1A as including some visually exposed portions on the connecting edge faces of the furniture members, in other embodiments, a cap (not shown) or other concealment element may partially or wholly conceal any portion of the connectors that would otherwise be visible at the connecting edge faces of the interconnected furniture members.

The furniture connectors of certain embodiments of the invention may be configured to contain or engage with fastening elements (not shown in FIGS. 1A, 1B and 1C) to facilitate fastening of furniture members to the furniture connectors. In certain embodiments, e.g. as shown in FIG. 1B, connectors **2a**, **2b**, **2c** include rails **5** including channels **18** with undercut sides **20**. The interaction between the fastening elements and channels **18** having at least one undercut side **20** is described in more detail below with reference to FIGS. 2A and 2B.

In some embodiments, such as the one shown in FIG. 1B, the length L of furniture-engaging portion 5 is greater than width W . Furniture-engaging portion 5 need not be continuous in some embodiments. For example, in certain embodiments, the furniture connector may extend essentially the entirety of the length of a furniture member to which it is configured to be attached, but furniture-engaging portion 5 may have several separate sections spaced periodically along its overall length L .

Although each furniture connector in FIG. 1B is shown as having similar or identical furniture-engaging portions, comprising rails 5, in other embodiments, a furniture connector may include furniture-engaging portions which are not similar to one another. For example, such connector may include one furniture-engaging portion which has an undercut channel, such as channel 18 with undercut 20, and another furniture-engaging portion which has holes and/or other means for inserting and/or engaging fastening elements. In some embodiments, the widths W , thicknesses t and/or lengths L of the furniture-engaging portions of a connector may be different from one another for a given furniture connector and/or between different furniture connectors utilized to interconnect a plurality of furniture members into a piece of assembled furniture. For purposes herein, the width of a furniture-engaging portion at a particular point along the length of the connector is the distance, as measured perpendicular to the length of the connector, from an outermost portion of the furniture-engaging portion to an inner portion of the furniture-engaging portion where the furniture-engaging portion cannot be further engaged with a groove in a furniture member.

FIG. 1C shows examples of locations where furniture connectors 2a, 2b and 2c may be used in forming a furniture assembly comprising a shelving unit 22. In this furniture assembly configuration, connector 2a is used at corners where two furniture members are interconnected. Connector 2b is used at connections where three furniture members meet, and connector 2c is used at the location where four furniture members are to be interconnected. The use of connector 2b and connector 2c allows multiple compartments/shelves to be created adjacently with a single wall between any two adjacent compartments/shelves.

One embodiment of an apparatus and method of securely interconnecting multiple furniture members **4** to one another is shown in FIGS. 2A and 2B. In this embodiment, furniture-engaging portion **5** is inserted into groove **6**. If a fastening element **24** is not already present in groove **6**, furniture-engaging portion **5** may be inserted in the direction of arrow **A**. If a portion of fastening element **24** is already present in groove **6**, furniture-engaging portion **5** may be inserted in the direction of arrow **B**. Once furniture-engaging portion **5** is inserted in groove **6**, fastening element **24**, which in the illustrated embodiment comprises a fastener comprising an eccentric piece **26**, may be rotated so that the eccentric piece **26** forces furniture-engaging portion **5** into secure, engaging contact with furniture member **4**. In the exemplary illustrated embodiment, fastening element **24** may be inserted into furniture member **4** such that eccentric piece **26** extends into groove **6** so that it can engage rail **5** via a hole **9** in furniture member **4**.

FIG. 2B shows eccentric piece **26** fully rotated such that furniture-engaging portion **5** is matingly and securely engaged with groove **6** of furniture member **4**. Rotated as such, eccentric piece **26** confines an end piece **28** of furniture-engaging portion **5** between eccentric piece **26** and a groove base **30**, thereby securing the furniture-engaging portion and furniture member to one another. Furniture-engaging portion **5** is prevented from sliding in the direction of arrow **B** by the friction between furniture-engaging portion **5** and the inside of groove **6** and eccentric piece **26**. Fastening element **24** itself is prevented from being removed from its hole **9** by an angled surface of eccentric piece **26** that interlocks with undercut side **20** of channel **18**. Various embodiments of fastening elements **24** are described in greater detail below with reference to FIGS. 4A and 4B.

As discussed above, even though furniture members can be securely interconnected to one another using embodiments of the furniture connectors disclosed herein, in certain embodiments the connection is reversible so that the furniture members can be disconnected and furniture assemblies can be disassembled, without difficulty and without adversely altering the structure of the furniture members and furniture connectors. For example, in the embodiment of FIGS. 2A and 2B, by rotating fastening element **24** counterclockwise, eccentric piece **26** is rotated

away from end piece **28** of furniture-engaging portion **5**. With eccentric piece **26** disengaged from end piece **28** of furniture-engaging portion **5**, fastening element **24** may be removed from its hole **9** and furniture-engaging portion **5** can be pulled from furniture member **4** in the direction of arrow **C**. Alternatively, fastening element **24** can be left in its hole **9**, and furniture-engaging portion **5** can be removed from groove **6** by sliding it in the direction of arrow **B** or in the direction opposite to arrow **B**. In some embodiments, connectors **2a**, **2b**, or **2c** may not extend to a front edge **29** and/or a rear edge **31** of furniture member **4**. In case the connectors are thusly hidden from frontal and/or rear view, their removal could be accomplished by sliding in the direction **C**. However, connectors **2** and furniture members **4** can, in a preferred embodiment, be disconnected without damaging or structurally altering the connectors, fastening elements **24**, or the furniture members.

The embodiment shown in FIG. 3 is one example of how a connector **2** having two furniture-engaging portions **5** comprising two rails with channels **18** therein can interconnect three furniture members **4a**, **4b**, **4c**. In addition to two furniture members **4a**, **4b** with grooves **6** in their connecting edges **8**, a post **32** comprising furniture member **4c** is connected using connector **2**. Furniture member **4c** may comprise a leg, rail, board or other support structure for use with a table, chair, elevated shelving unit or other suitable furniture assembly, or, in certain embodiments may simply be used as a corner connector to reinforce to strength of the interconnection provided by furniture connector **2** alone. A groove in post **32** includes a slot **34** where a corner portion **36** of connector **2** may be inserted. The remaining portions of connector **2** may be inserted into grooves **6** of furniture members **4** and fastened as described above with reference to FIGS. 2A and 2B. Post **32** may optionally include recesses **38** for insertion of end portions **40** of furniture members **4**. By securing end portions **40** within recesses **42**, furniture members **4** may be more securely attached to post **32**.

One alternative embodiment of a fastening element for engaging and securing a furniture-engaging portion of a furniture connector to a furniture member is shown in FIG. 4A. Furniture-engaging portion **5** includes a channel **18** that has an undercut side **20**. In some embodiments, only one side of channel **18** is an undercut side, while

in other embodiments, both sides are undercut sides. Fastening element 24', as shown in exploded view in the figure, is configured as two separable pieces, with an eccentric piece 26', which in this example is rotatably engagable with a slot-head screw component 44. With furniture-engaging portion 5 placed in groove 6, fastening element 24' may be rotated such that eccentric piece 26' pushes furniture-engaging portion 5 into contact with groove base 30.

In embodiments where channel 18 is constructed to be approximately as wide as the diameter of eccentric piece 26', fastening element 24' may be placed in a hole 46 and furniture-engaging portion 5 may be inserted into groove 6 starting at an end (e.g., end 45) of furniture member 4. In embodiments where channel 18 is wider than the diameter of eccentric piece 26', the furniture-engaging portion may, in addition, be inserted first, either from an end of furniture member 4 or from the top 47 of groove 6, and fastening element 24' then may be inserted into channel 18.

Furniture-engaging portion 5 does not necessarily need to comprise a rail including a continuous channel, as previously illustrated. As shown in FIG. 4B, in alternative embodiments a furniture connector having a differently configured furniture-engaging portion may be used to interconnect furniture members 4 with a furniture connector. In this particular embodiment, furniture connector 2' includes a rail 5' comprising a catch component 50. Fastening element 24'' includes a spacer 49 and a bilateral hook 48 that may be rotated to engage catch 50. As hook 48 rotates clockwise, the decreasing inner radius of hook 48 pulls catch 50 further into groove 6 and secures it therein.

FIGS. 4A and 4B show only two of a wide variety of fastening element and furniture-engaging portion designs configured to engage fastening elements. These embodiments are intended to be exemplary and other suitable fastening elements and furniture-engaging portion configurations that would become apparent to those skilled in the art upon consideration of the teachings herein or could be developed or discerned using no more than ordinary skill in the art and/or routine experimentation and optimization may be used instead of or in addition to the particular embodiments described herein, and such fastening elements and furniture-engaging portion configurations that fall within the scope of the claims are within the scope of the

invention. For example, in certain embodiments, a fastening element may comprise a conventional machine screw and a furniture-engaging portion may include a threaded bore.

In some embodiments, a fastening element may permit tool-free operation. For example, the fastening element may have a finger grip or other structure for rotating, sliding, pushing, pulling or otherwise operating the fastening element without the need for tools.

Adhesive may be used, if desired, to make certain connections permanent, for example, by including adhesive material in groove 6 before inserting a furniture-engaging portion of a furniture connector in the groove and securing it with a fastening element. An adhesive connection as formed directly between furniture members or as used to secure an interconnection between two furniture members via connection of each furniture member to a furniture connector, wherein all of the connections are secured solely by the use of adhesive, however, is not considered to be use of a "fastening element" as that term is used herein. In some embodiments, however, a first furniture-engaging portion may be reversibly fastened to a furniture member via a fastening element of the invention, and a second furniture-engaging portion may be permanently attached with the addition of adhesive.

The reversibility of connections, provided according to certain embodiments of the invention, can permit improved versatility when adding extensions to furniture assemblies. One example of this versatility is shown in the embodiment of FIGS. 5A and 5B. A furniture assembly 52 comprising a plurality of furniture members 4 includes several shelves 54, sliding doors 56, and swinging doors 58. Various embodiments of connectors disclosed herein may be used to interconnect the furniture members 4. An extension 60 may be added to furniture assembly 52 by using additional furniture members 4 and connectors 2. Connectors 2 may be removed from interconnection points in furniture assembly 52 and replaced with other connectors that can connect a different number of furniture members. For example, a top right corner connector, which connects two furniture members in FIG. 5A may be replaced by a connector that connects three furniture members, etc.. Other suitable connector substitutions also may be made along the right side of furniture assembly 52.

Additional furniture members may then be fastened to furniture-engaging portions that protrude from the right side, as illustrated, of the furniture assembly. The connectors originally used on the right side, as illustrated, of furniture assembly 52 then may be used as connectors for the right side, as illustrated, of extension 60, if desired.

As a result of replacing the connectors on the right side, as illustrated, of furniture assembly 52, the presence of double walls is avoided when addition 60 is appended. If, by contrast, the connections on the right side, as illustrated, of furniture assembly 52 were irreversible, alternate arrangements would be required to provide support for the horizontal shelves/compartments of the left side, as illustrated, of extension 60. An additional set of vertical furniture members might have to be used to provide this support, resulting in double vertical walls at the section where extension 60 meets the original furniture assembly 52.

The reversibility of interconnections between furniture members enabled via use of inventive furniture connectors and furniture members according to certain embodiments of the invention, also may allow for versatility in assembling/reassembling furniture assemblies in different configurations. For example, as shown in FIGS. 6A and 6B, a furniture assembly assembled in a first configuration 62 can be disassembled (either partially or entirely) and reassembled in a second configuration 64 using some or all of the same components originally making up assembly 62. For example, in an exemplary embodiment, a kit of parts comprising a plurality of furniture members, furniture connectors, and, optionally, fastening elements of the invention and/or custom inserts for furniture members allowing attachment of doors, shelves, wheels, handles, etc. could be provided, which could be assembled into a plurality of different furniture configurations, for example a desk, a bookcase, an entertainment center, a cabinet, etc. Instructions could be provided with such a kit instructing a user as to how to assemble, disassemble, and reassemble the various provided components into the variety of furniture configurations.

In typical prior art knock-down furniture, furniture members typically are not interchangeable due to the connection system used. For example, in some knock-

down furniture kits, otherwise similar furniture members have pre-drilled holes in different locations because the pre-drilled holes need to be aligned with certain fastener locations. In embodiments of the present invention, many furniture members are interchangeable because fastening elements can be fastened at a plurality of locations along the length of a furniture connector and/or connecting edge(s) of the furniture members. In some embodiments, more than one face of various furniture members may be presentable as an exterior face of a furniture assembly. In combination with various connection systems disclosed herein, such furniture members may allow users to choose whether fastening elements will be visible in the assembled furniture assembly or not, or may allow users to decide which color or surface texture will be visible on the exterior of the furniture assembly.

Components for a furniture assembly may be packaged in any convenient way, and may form a kit. The kit may include furniture connectors, fastening elements, furniture members, instructions and any other components useful for assembling and/or using the furniture assembly, or any combination thereof. Various kits may have different types and different quantities of various components, and additional components could be sold separately and combined into “expansion” kits. Instructions may be provided for assembling the connectors and furniture members into a furniture assembly. Instructions also may be provided for assembling a furniture assembly into a first configuration, disassembling a furniture assembly, and/or assembling a furniture assembly into a second configuration.

“Instructions” can and often do define a component of promotion, and typically involve written instructions on or associated with packaging of kits or components of the invention. Instructions also can include any oral or electronic instructions provided in any manner. The “kit” typically, and preferably, defines a package including both any one or a combination of the components of the invention and the instructions, but can also include the components of the invention and instructions of any form that are provided in connection with the components in a manner such that a purchaser or user of the components will clearly recognize that the instructions are to be associated with the specific components.

While several embodiments of the invention have been described and illustrated herein, those of ordinary skill in the art will readily envision a variety of other means and structures for performing the functions and/or obtaining the results or advantages described herein, and each of such variations, modifications and improvements is deemed to be within the scope of the present invention. More generally, those skilled in the art would readily appreciate that all parameters, dimensions, materials, and configurations described herein are meant to be exemplary and that actual parameters, dimensions, materials, and configurations will depend upon specific applications for which the teachings of the present invention are used. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific embodiments of the invention described herein. It is, therefore, to be understood that the foregoing embodiments are presented by way of example only and that, within the scope of the appended claims and equivalents thereto, the invention may be practiced otherwise than as specifically described. The present invention is directed to each individual feature, system, material and/or method described herein. In addition, any combination of two or more such features, systems, materials and/or methods, provided that such features, systems, materials and/or methods are not mutually inconsistent, is included within the scope of the present invention. In the claims (as well as in the specification above), all transitional phrases or phrases of inclusion, such as “comprising,” “including,” “carrying,” “having,” “containing,” “composed of,” “made of,” “formed of,” “involving” and the like shall be interpreted to be open-ended, i.e. to mean “including but not limited to” and, therefore, encompassing the items listed thereafter and equivalents thereof as well as additional items. Only the transitional phrases or phrases of inclusion “consisting of” and “consisting essentially of” are to be interpreted as closed or semi-closed phrases, respectively.

What is claimed is: